

NOTES ON A PSYCHID NEW TO NORTH AMERICA  
(*FUMEA CASTA* PALLAS, Lepidoptera: Psychidæ)

BY DONALD W. FARQUHAR<sup>1</sup>

Harvard University

In 1931, workers from the Gipsy Moth Laboratory in Melrose Highlands, Massachusetts, found examples of an unknown case-bearer associated with the introduced beech scale, *Cryptococcus fagi* Bar., near Jamaica Pond, Boston, Massachusetts. Specimens of the case-bearer brought into the laboratory were observed to feed on the eggs and agamic females of the scale, but since this choice of food was decided to be purely incidental and the chief interest of the laboratory was in the scale rather than in the case-bearer, no further work on the latter was done. The writer, however, was interested in the identity of the insect and sent examples of the cases to Dr. Frank Morton Jones of Wilmington, Delaware, who was unable to place them among any of the known North American forms and suggested that an attempt be made to secure adults. In 1932 two male adults were obtained, and in 1933 over 2,000 adults of both sexes were reared from larvæ collected just prior to pupation; this ample material enabled careful study, resulting in the determination of the insect as the European *Fumea casta* Pallas. A discussion of the characters establishing its identity is given in the paper which follows, while the present paper deals with the distribution and biology.

<sup>1</sup>The writer wishes to express his deep appreciation to Frank Morton Jones, specialist in the Psychidæ, who has been most generous in giving of his time and knowledge. A paper which follows, and which bears the name of the writer of the present paper as coauthor, is almost entirely Dr. Jones' own work.

Thanks are also given to Harold Morrison, C. F. W. Muesebeck, A. B. Gahan, and R. A. Cushman, all of the taxonomic unit of the Bureau of Entomology, who examined parasitic material and made determinations where possible.

In the Old World, *Fumea casta* Pall. is widely distributed in England, on the European mainland, in Asia Minor and Algeria. The first specimens discovered in North America were found between Jamaica Pond and the Arnold Arboretum, in Boston, Massachusetts; and subsequent scouting showed this region to be near the center of an area of some 50 square miles (Fig. 1), heavily infested at the center, and

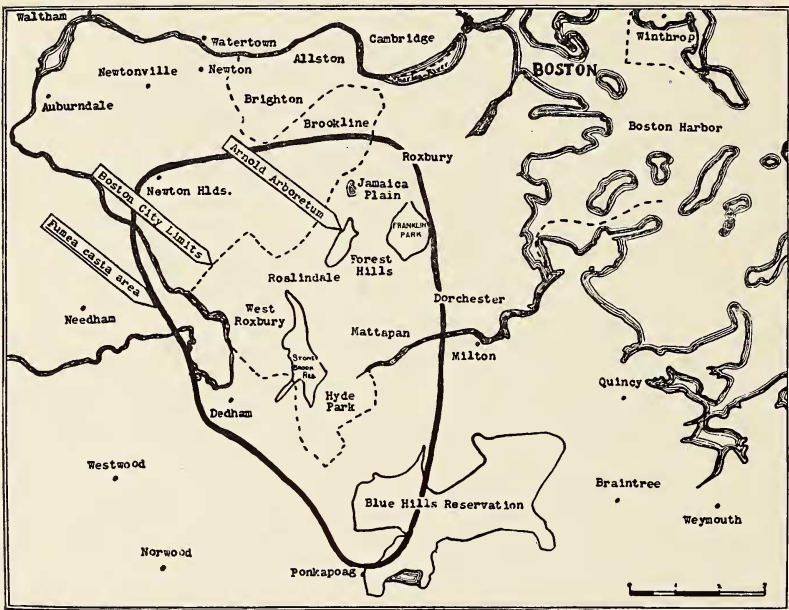


FIG. 1. Map showing regions in Boston and vicinity infested with *Fumea casta* Pall.

gradually diminishing in density toward the edges. Approximately half of the area comprised those sections within the limits of the City of Boston known as Jamaica Plain, Forest Hills, Roslindale, West Roxbury, Hyde Park, Mattapan, the Arnold Arboretum, Stoney Brook Reservation, and Franklin Park; the remaining 25 square miles were in Brookline, Newton Highlands, Dedham, Milton, and the Blue Hills Reservation. A second, and far removed, colony was later found by Dr. Jones in the Morris Arbore-

tum, near Germantown, Pennsylvania; females from this colony readily mated with Massachusetts males; many of the older plantings in the Morris Arboretum are said to have originated in the Arnold Arboretum, which may explain the mode of introduction. A third colony is indicated by empty cases, apparently identical with those of *Fumea*, found by Dr. W. T. M. Forbes in Bancroft Woods, in Worcester, Massachusetts. Other colonies are to be anticipated.

*Larva and Case.* The larvæ hatch during June and early July, and at once each individual constructs a small silken case, or "bag," in which, enlarged from time to time, it spends its entire larval and pupal period. This elongate bag is adorned on the outside with bits of grass and other ground debris, longer pieces being attached lengthwise and often projecting slightly beyond the posterior end of the bag. Through an anterior opening, the larva is able to thrust out its head and thorax for purposes of feeding, moving, or working on the case; the posterior end of the case has a smaller opening, usually collapsed but readily opened from within for the expulsion of excrement. During resting and molting periods the anterior edge of the bag is firmly attached by silken threads to some object of support.

Food is taken only during the larval period, and consists chiefly of grasses, mosses, lichens, and other low plants, although the insect may occasionally exhibit carnivorous tendencies, as evidenced by feeding on scale insects and, in the laboratory when very hungry, on the living larvæ and helpless adult females of its own species.

As in many other members of this family, the larval period is very protracted (Fig. 2)—occupying approximately eleven months—and growth is correspondingly slow. From the time of hatching in June or July until the onset of winter, the larval case attains a length of but three millimeters. Hibernation takes place in crevices in the bark of tree trunks, or beneath stones, branches of trees, and other objects resting on the ground. In the spring, feeding is resumed, and growth is more rapid. When the larvæ are mature, in late May and early June, the cases of the females are generally larger than those of the males. Measurements of fifty female cases at this time, inclusive of the loose ma-

terial projecting beyond the end of the case proper, showed a range in length from 8 to 16 mm., with an average of 12.1 mm.; measurements of the same cases, exclusive of the loose material, ranged from 7.5 to 10 mm. with an average of 8.8 mm. Fifty male cases ranged from 7.5 to 13.5 mm., with an average of 10.2 mm., inclusive of the loose material; when measured without the loose material, these male cases ran from 6.5 to 8 mm., with an average length of 7.5 mm.

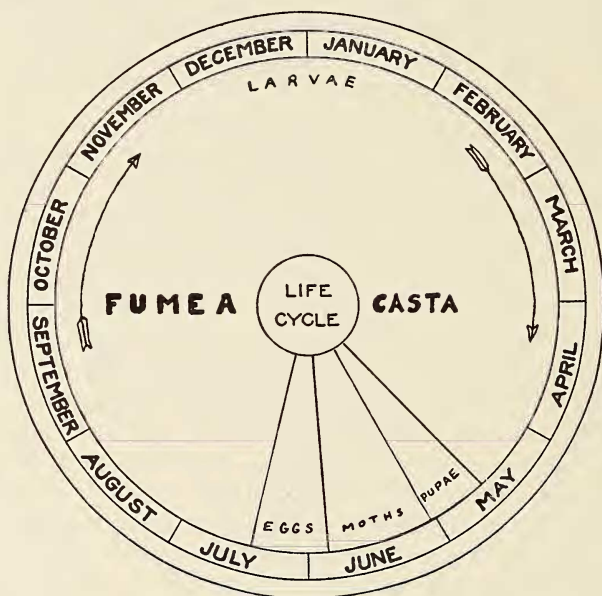


FIG. 2. Life cycle of *Fumea casta* Pall. in Massachusetts.

When the larvæ become full grown, they forsake the ground and low plants on which they have spent their entire lives up to this point, and climb up tree trunks, telegraph poles, fence posts, stone walls, sides of dwellings, etc., to attach their cases for pupation. The height to which the larva ascends before attaching the case varies from a few inches to twenty feet, but few are attached above six feet. Although the larvæ on the ground easily escape notice even in densely populated colonies because of

the close resemblance of their cases to the surroundings, the cases attached for pupation are conspicuous and often render unsightly the objects of attachment.

*Pupa.* Like the larval period, the pupal period is passed within the bag. After firmly attaching the bag and closing its anterior end in preparation for pupation, the larva reverses its position within the bag so that its head comes to lie at what was previously the bag's posterior opening. Rarely, the larva fails to reverse its position, but in such instances the adult is unable to escape from the bag and perishes within it.

The pupæ of the two sexes are quite different in appearance. That of the male measures from 4.5 to 5 mm. in length, and has the general appearance of orthodox moth pupæ. That of the female measures 5.3 to 7.5 mm. in length, and is noteworthy because of the marked reduction in size of the antennæ, wings, and legs, all of which occupy a very limited area of the anteroinferior portion of the pupa.

In both sexes, when the pupa is ready to yield the imago, it squirms forward in the bag until the head of the pupa projects from the bag's opening; in the male this squirming continues beyond the stopping place in the female, until not only the head projects, but also the thorax and three to five segments of the abdomen. In this position the adult emerges.

The duration of the pupal period is about twelve days in the male, and about seven days in the female.

*Adult Male.* (Plate 2, figs. C and F.) The male moth is uniformly dark brown in color, and is provided with strong wings to which the scales are loosely attached. The alar expanse varies from 10.5 to 13 mm. (Chapman and Tutt give measurements of 9-15 mm. for European *casta*.) No food is taken by the adult, and the duration of life is but a very few days at most.

*Adult Female.* (Plate 2, figs. A and B.) In the higher Psychidæ, to which all the North American Psychids belong with the exception of *Solenobia walshella* Clem., the females are maggot-like and devoid of antennæ, eyes, and legs. In the lower or less specialized Psychidæ, the females



are provided with functional legs, antennæ, and eyes. In this latter group belong the native *Solenobia walshella* and the introduced *Fumea casta*. The female is wingless, and the body is practically naked save for a thin scattering of pale hairs and a dense ring of pale, silky hairs at the end of the abdomen surrounding the base of the long, extensible ovipositor. After the female *casta* has feebly squirmed her way out of the pupa-shell, she takes up her waiting posture at the lower end of the bag, still maintaining contact with the interior of the bag by means of her metathoracic legs; often her head, antennæ, and prothoracic legs remain encased in the corresponding parts of the pupa-shell which are broken away from the rest of the shell during emergence. Like the adult male, the adult female takes no food, and her life in this stage is limited to a very few days.

*Mating.* Immediately after emerging, the female liberates the attractant which summons males within perceiving distance. A male receiving this attractant evidences its perception by becoming suddenly very much excited. He takes flight and follows an erratic course in the direction of the female. Seldom is the sense of perception sufficiently keen to enable a flight direct to the object of search; the usual course is to fly to the general vicinity of the female, then after alighting, with vibrating antennæ and quivering wings, the male continues his quest on foot. His excitement increases in pitch when he attains the bag on which his mate is waiting, and he usually makes several impetuous attempts to clasp nearby objects before making successful contact with the female genitalia. The commencement of copulation is indicated by the male suddenly becoming quiescent, resting with the wings sloped sharply downward (in a "sloping-roof" posture). Seven timed matings indicate a copulation period of six to thirty-eight minutes, with an average of 20.4 minutes. Both sexes may mate more than once, although such successive matings in the female usually occur only when the original mating has been interrupted before completion.

*Eggs.* As soon as mating is completed, the female probes with her ovipositor to reinsert it in her empty pupa-shell, which lies within the bag; in this process of probing she is

assisted by the metathoracic legs, the tibia and tarsus of which are still within her bag, and probably facilitate the reinsertion of the ovipositor by acting as a guide. The eggs are pale in color and very delicate, and are deposited by means of the extremely manœverable, telescopic ovipositor, which, when fully extended, equals the length of the remainder of the female's body. When the last of her 150-odd eggs have been deposited, the female withdraws her ovipositor, closing the opening to her egg-filled pupa-shell with a plug of fuzz from the tip of her abdomen; she then relinquishes her hold on the bag, and drops to the ground to die. The eggs hatch in thirteen to fifteen days, the young larvæ leaving the parental bag via its open end.

*Dispersal.* Since the adult female is incapable of flight or other locomotion, the dispersal of the species depends on the wanderings of the larvæ, and especially their transportation by other agencies. Just as human beings have unwittingly brought this insect to America, so, too, its dispersal within America is probably greatly assisted by man's conveyances. Another factor in the dispersal is the wind; as soon as the newly hatched larvæ have constructed their tiny cases, they have the habit of dropping themselves down on a silken thread, in which condition they are easily picked up by wind currents to be dropped perhaps at some distance away. Since evidence indicates a sojourn of the insect in this country of at least two decades, with these various factors aiding in its distribution, the insect probably will soon be found in many, and possibly widely separated localities.

*Parthenogenesis and Preponderance of One Sex.* Although parthenogenesis has been recorded in the genus *Fumea* in Europe—and, indeed, has been reported in *Fumea casta* (Fauna Boica II, 91, Schrank)—no evidence of this phenomenon has been observed in Massachusetts *casta*. Fifteen unmated females from the Boston colony were isolated in an experiment designed to detect evidences of parthenogenesis. All died without ovipositing, within five days after emergence.

In both Europe and America, authors have remarked upon the occasional striking preponderance of one sex over

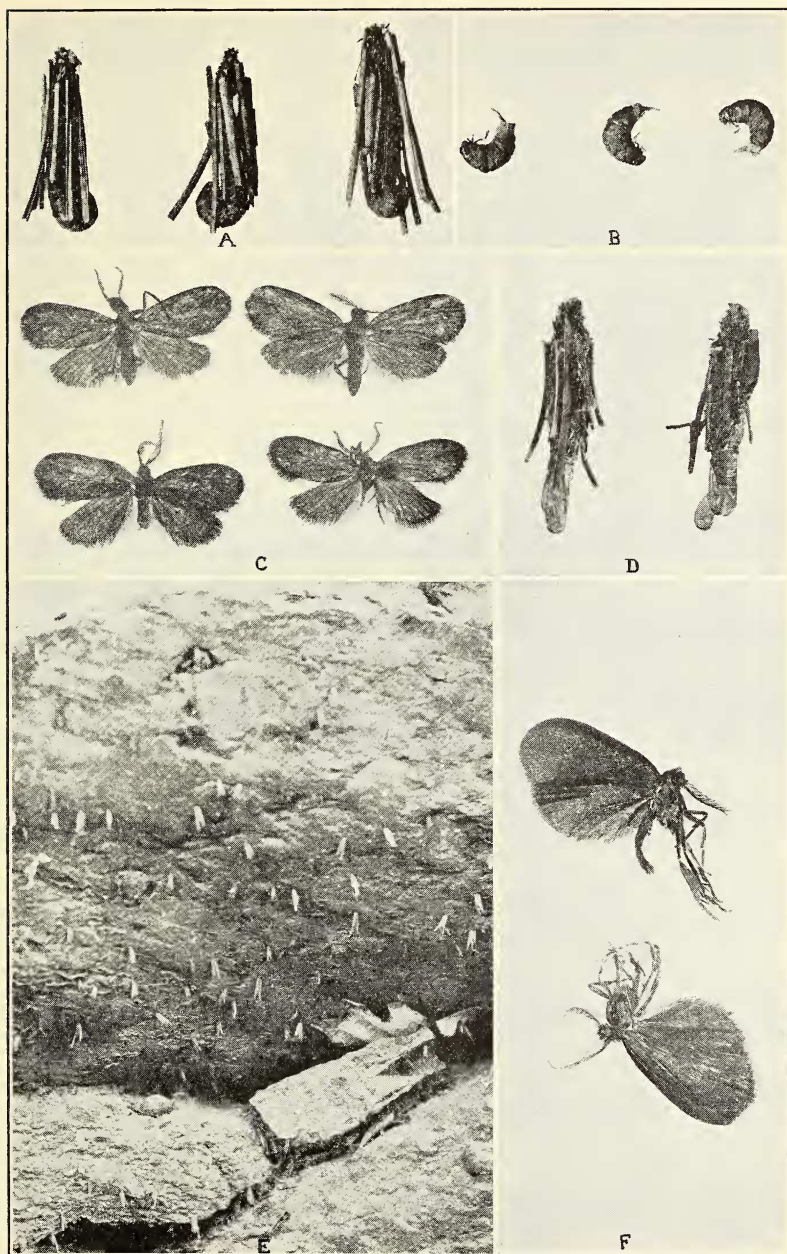
the other in Psychid rearings. In parthenogenetic species, females are either the only form known or greatly outnumber the males. In America, Dr. Jones has mentioned (Tr. Am. Ent. Soc., LIII, 310, 1927) a collection of thirty-odd cases of *Eurukuttarus edwardsi* Heyl. of which only one was female; the same author (Ent. News, XXXIII, 130, 1922) bred some forty males without a single female from a collection of *Psyche celibata* Jones. Returning to *Fumea casta*, a similar numerical ration between the sexes was found in many of the Massachusetts collections, as shown in the following table based on adults bred from cases collected at time of pupation; where cases failed to yield adults, they were opened and the sex determined from the enclosed pupæ; in those few cases where the larvæ died, accurate sex determination was not considered possible, and such individuals are ignored in the tabulation:

TABLE 1.—Sex ratio in certain collections of *Fumea casta* in Massachusetts.

Date of collection	Place of collection	Number of individuals	% ♂ ♂	% ♀ ♀
May 6, '33	Arnold Arboretum .....	7	100	000
May 6, '33	Stoney Brook .....	70	100	000
May 12, '33	Stoney Brook .....	69	100	000
May 13, '33	Arnold Arboretum .....	100	100	000
May 22, '33	Arnold Arboretum .....	130	100	000
May 22, '33	Fenway .....	25	100	000
May 22, '33	Jamaica Pond .....	100	93	7
June 5, '33	Jamaica Pond .....	375	34	66

Interpretation of the above table is complicated by the fact that the Jamaica Pond colony was some two weeks behind the other colonies in reaching maturity; in fact, for a time the larvæ of this colony were considered as possibly of another species because of their smaller size. Therefore, the high percentage of females in the latest collection does not necessarily mean that similar results would have obtained if later collections had been made at the other sites. It appears from the table that the earliest larvæ to pupate are the males, which conforms with the condition in many other Lepidoptera. The striking preponderance of males





Farquhar—*Fumea casta*



may be due to some peculiar habit of the female in choosing different or more concealed places for pupation than the males, thus rendering their cases less liable to detection by the collector.

*Parasites.* Apparently *Fumea casta* has become established in America without its European parasites. Although the writer reared over 2,000 adult moths from cases collected at the time of attachment, only eleven parasites emerged from the material, and probably all eleven of these emerged from a single host. They proved to be a new species and genus of Eulophidæ related to *Elachertus*, as yet undescribed. Several hundred cases collected in Massachusetts were sent to Dr. Jones, and from them he reared eleven specimens of *Dibrachys boucheanus* (Ratz.) [A. B. Gahan]. Dr. Jones also reared two specimens of *Itoplectis conquisitor* (Say) [R. A. Cushman] from cases collected in the Morris Arboretum in Pennsylvania.

In addition to these definite instances of parasitism, two species were found in the field associated with *Fumea casta*: A female of *Ephialtes equalis* (Prov.) [R. A. Cushman] was taken in the field with its ovipositor thrust through a bag attempting to oviposit in the contained pupa. A specimen of *Eunotus lividus* Ash. [A. B. Gahan] was found in a tube in which cases of *casta* were being collected, and probably gained entrance to the tube by being on or within one of the cases when it was collected.

#### EXPLANATION OF PLATE 2.

Fig. A.—Adult females on their bags (x2).

Fig. B.—Adult females (x2).

Fig. C.—Adult males (x2½).

Fig. D.—Bags from which adult males have emerged leaving their empty pupa-shells protruding from the bags (x2½).

Fig. E.—Bags attached for pupation on a stone wall in a heavy infestation (⅓ natural size).

Fig. F.—Adult males (x3½).